CALCULATING WEEKLY PARTICULATE AND VAPOR RADIOACTIVE AIR EMISSIONS FROM SAMPLED STACKS AT TA-53

Purpose

This Air Quality Group procedure describes the methods used by ESH-17 to quantify weekly particulate and vapor radioactive air emissions from sampled stacks at LANSCE (TA-53).

Scope

This procedure applies to individuals in the Air Quality Group assigned to perform particulate and vapor emission calculations for LANSCE stacks monitored by the particle sampling system.

In this procedure

This procedure addresses the following major topics:

Topic	See Page
General Information	2
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Hazard Control Plan

The hazard evaluation associated with this work is documented in HCP-ESH-17-Office Work.

Signatures

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08/20/99

General information

Attachments

This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Example of PVAP spreadsheet layout	3
2	List of media efficiency factors	2

History of revision

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	8/13/99	New document with improved methodology but derived from 53 FMP 104-06.3.

Who requires training to this procedure?

The following personnel require training before implementing this procedure:

- Rad-NESHAP Project personnel performing all or part of this procedure
- ESH-17 LANSCE Coordinator
- Technical reviewer of results

Training method

The training method for this procedure is **on-the-job training** conducted by the preparer or a previously trained individual and is documented in accordance with the procedure for training (ESH-17-024).

General information, continued

Definitions specific to this procedure

Particulate emissions: Radioactive emissions from a sampled stack that are captured on a glass fiber sample filter. These filter samples consist of filterable particles of activation products at LANSCE. These filters may also contain some gaseous and vapor emissions absorbed onto the filter. See Attachment 3 for a more complete list of particulate and vapor (PVAP) radionuclides.

Vapor emissions: Volatile radioactive emissions from a sampled stack that are captured on a charcoal filter. These vapors include isotopes of Br, Hg, Se, and others. See Attachment 3 for a more complete list of particulate and vapor (PVAP) radionuclides.

PVAP: Particulate and Vapor Activation Products. General term used to describe particulate and vapor emissions, as defined above. Also, the spreadsheet template used to analyze these emissions is called "PVAP.xlt" or some similar name (e.g., PVAP-v1-7.xlt)

References

The following documents are referenced in this procedure:

- 40 CFR 61, Subparts A and H, "National Emission Standards for Hazardous Air Pollutants"
- ESH-17-024, "Personnel Training"
- ESH-17-119, "Evaluation of Radioactive Air Emissions From Sampled Stacks"
- ESH-17-127, "Determination of Stack Gas Velocity and Flow in Exhaust Stacks, Ducts, and Vents"
- HCP-ESH-17-Office Work
- Memo ESH-17:99-251, "Efficiency of Paper and Charcoal Stack Sample Filters at TA-53"

Note

Actions specified within this procedure, unless preceded with "should" or "may", are to be considered mandatory guidance (i.e., "shall").

Calculating emissions

Description of sampling and analysis process

ESH-17 determines the amount of radioactive particles and vapors emitted from LANSCE (TA-53) stacks by filtering a sample of air from the stack through one or more paper filters and charcoal cartridges. The paper and charcoal filters are counted for isotopic gamma emitters. Some vapors are also partially captured on the paper filters.

The officially reportable emission values are determined through these weekly gamma isotopic sample analyses.

Overview

Based on the stack and sample flow rates and the amount of radioactivity present on the filter and cartridge, as determined by the analytical laboratory, the ESH-17 **LANSCE coordinator** or other qualified, trained person calculates the amount of radioactivity emitted from the stack into the environment using the equations described in this procedure.

Current stack and sample flow rates

JCNNM determines the maximum pre-cycle stack flow rates for each stack and configuration (ESH-17-127). The ESH-17 **LANSCE coordinator** maintains a record of these flow data and uses the data for effluent calculations. Use the maximum stack flow rate measured by JCNNM during the time period under analysis (Q_{stack}). An online flow rate system, correlated to the JCNNM measurements, confirms the flow rates. The sample flow rate is set to 2 actual cubic feet per minute. Weekly emissions are calculated using the reported stack and sample flows.

Performing calculations

Calculations described in this procedure are normally performed electronically using an Excel spreadsheet template named “PVAP.” See the README sheet in the spreadsheet file for instructions on using the spreadsheet. However, these calculations may be done by any means as long as the *methodology* is the same. If done by other means than PVAP (such as manually), the analyst must sufficiently document the details of the calculation to demonstrate and allow verification that the *methodology* is the same.

Calculating emissions, continued

Calculating equivalent decay-corrected activity on media

Determine the work-shift decay-corrected activity on the medium for **each** gamma-emitting radionuclide at LANSCE using the following equation:

$$A_{media} = \frac{A_{HPAL} * [\mu A * hr]_{total}}{\sum_{shift=1}^{N} [\mu A * hr]_{shift} * e^{-\lambda * \Delta t_{shift}}}$$

where: A_{media} is the total activity of radionuclide x collected on the sample media

A_{HPAL} is the activity of radionuclide x collected on the sample media, as reported by HPAL. Note that this activity is already decay corrected (by HPAL) to the time that the sample medium was removed from the sampling system.

$[\mu A*hr]_{shift}$ is the microamp-hours of beam operation during a specific shift

$[\mu A*hr]_{total}$ is the total microamp-hours of beam operation during the sampling period

λ is the radioactive decay constant of radionuclide x

Δt_{shift} is the time interval from the midpoint of each shift to the end of the sample period. This time interval and the decay constant must be in the same time units.

The result of this calculation is an equivalent activity for each radionuclide weighted by the relative beam microamp-hours during each shift and decay-corrected back to the middle of that shift.

Calculating emissions, continued

Adjusting for collection efficiency

Using the above data by radionuclide and an appropriate value for the sampling media collection efficiency for radionuclide x, calculate the total activity of radionuclide x that went through the sample system by:

$$A_{sample} = \frac{A_{media}}{\varepsilon_{media}}$$

where: A_{sample} is the total activity of radionuclide x through the sample system

A_{media} is the total activity of radionuclide x collected on the sample media calculated above

ε_{media} is the collection efficiency of the sample media for radionuclide x. These values are given in Attachment 2.

Sample-to-stack flow-rate corrections

By multiplying each of the above activities in the sample system by the ratio of the stack flow rate to the sample flow rate, the total emitted activity of each radionuclide can be determined:

$$A_{Stack} = A_{sample} * \frac{Q_{stack}}{Q_{sample}}$$

where: A_{stack} is the total activity of radionuclide x that was emitted out the stack

Q_{stack} is the volumetric flow rate of the stack (maximum measured by JCNNM during time period)

Q_{sample} is the volumetric flow rate of the sample system

The result of these calculations is the emissions, by radionuclide, during the sample period.

Calculating emissions, continued

Emission correction factors

As described in the *Estimating Missing Data* section of ESH-17-119, "Evaluation of Radioactive Air Emissions From Sampled Stacks," occasionally a sample period may be incomplete due to equipment malfunction or some other problem. In such cases, a scaling factor or emission correction factor must be developed to allow the emissions to represent an entire sample period. If an emission value has been determined to be invalid, an estimated value, or a replacement value, may be used in its place. Because of the strong correlation between microamp-hours of operation and PVAP emissions at LANSCE, determining a conservative replacement value is relatively easy.

Documenting emissions

Documenting the calculations	The individual performing the calculations in this procedure documents the work performed (normally by printing the spreadsheet) and then forwards the documentation to a technical reviewer (trained to this procedure) for review.
Obtaining technical review of results	The **technical reviewer** checks all the documentation for accuracy and technical correctness. If any data were hand entered, the **technical reviewer** checks all of the entered data. If data were entered or uploaded electronically, the **technical reviewer** checks at least 10% of the entered data.
Forwarding results to project leader and to Records Coordinator	The **ESH-17 LANSCE coordinator** forwards the results to the Rad-NESHAP Project Leader within four weeks of completion and maintains a complete documentation package of all emissions determinations, including analysis results, flow measurements, assumptions, any other information relevant to emission calculations. Periodically forward document packages to the ESH-17 Records Coordinator.
Revising automated calculation methods	After writing or revising an automated (e.g., spreadsheet) calculation method used to calculate emissions at LANSCE, the **ESH-17 LANSCE coordinator** or a qualified, trained designee has a technical reviewer (trained to this procedure) verify the function of the method through hand calculations or other means, and documents these reviews.

Records resulting from this procedure

Records

The following records generated as a result of this procedure are to be submitted to the Records Coordinator **within four weeks** after emissions calculations are done:

- Datasheets generated as a result of performing this procedure, including technical and peer review.
- Documentation of peer review of new or revised spreadsheets or other techniques used to calculate emissions
- Documentation of any emissions correction factors, if necessary.

EXAMPLE OF PVAP SPREADSHEET LAYOUT

Note: the entire emissions spreadsheet for this example report is not reproduced here.

TA-53 Air Emissions Report: Particulate & Vapor Activation Products

Part One: Sample Data

TA-53-BLDG-003-ES-03

Stack ID	es-3	
Week #	50	
Monthly Report Period	Dec-98	
Stack Flow Rate	17,282	cfm
Sample Flow Rate	2	cfm
Sample Start Date	30-Nov-98	
Sample Start Time	06:00	
Sample Removal Date	7-Dec-98	
Sample Removal Time	06:00	
Sample Time	7	days

yellow = user-entered data
blue = automatic calculations

Part Two: Analysis Data

entry number	HPAL REPORT DATA: Radionuclide	HPAL REPORT DATA: Reported Activity (uCi)	Database Radio-nuclide	Database lambda (1/hr)	Database collection media	Database collection efficiency	Calc'd decay factor	Collected Activity (microcuries)	Activity thru sample filter (microcuries)	Stack Emissions (microcuries)
1	Be-7	4.50E-04	BE-7	5.407E-04	paper	100%	9.57E-01	4.70E-04	4.70E-04	4.06E+00
2	Na-24	6.10E-04	NA-24	4.611E-02	paper	100%	1.24E-01	4.90E-03	4.90E-03	4.24E+01
3	Br-76	5.30E-02	BR-76	4.278E-02	charcoal	65%	1.34E-01	3.95E-01	6.08E-01	5.25E+03

EXAMPLE OF PVAP SPREADSHEET LAYOUT, CONTINUED

Part Three: Beam Operations Data

Sample Start Date	30-Nov-98	
Sample Start Time	06:00	
Sample Removal Date	7-Dec-98	
Sample Removal Time	06:00	
Sample Time	7	Days
	168	hours
Shift Length	8	hours
# shifts	21	shifts

COPY MICROAMP-HOUR DATA
(LANSCE-6, ENTERED INTO
DAILY SURVEY SPREADSHEET)
INTO YELLOW AREA AT RIGHT.

TYPICALLY, ONLY DAYS 1-7 WILL BE REQ'D

Microamp-hour data:
Copied from DSRP beam operations data
(LANSCE-6)

	06:00 - 13:59	14:00 - 21:59	22:00 - 06:00
Day	first shift	second shift	third shift
1	1946.9	6842.3	7.1
2	7379.6	7380.5	7634.3
3	7325.4	7831.2	7681.5
4	7654.8	7174.1	7489.8
5	7091.5	7875.4	7924.7
6	7904.1	3022.7	7062.7
7	2662.4	5549.7	7876.5
8			
9			
10			
11			
12			
13			
14			
15			

IF BEAM OFF ALL WEEK, ENTER "1" IN EACH APPLICABLE CELL

EXAMPLE OF PVAP SPREADSHEET LAYOUT, CONTINUED

Part 4: Decay correction (automatic)

Sum; total ops during sample period 133317 uA-hrs

Shift#	Day	Shift	Time		microamp-hours	Op Fraction	time to midpt
1	Monday	Midnt	00:00-08:00		1947	0.015	164
2	Monday	Day	08:00-16:00		6842	0.051	156
3	Monday	Swing	16:00-00:00		7	0.000	148
4	Tuesday	Midnt	00:00-08:00		7380	0.055	140
5	Tuesday	Day	08:00-16:00		7380	0.055	132
6	Tuesday	Swing	16:00-00:00		7634	0.057	124
7	Wednesday	Midnt	00:00-08:00		7325	0.055	116
8	Wednesday	Day	08:00-16:00		7831	0.059	108
9	Wednesday	Swing	16:00-00:00		7681	0.058	100
10	Thursday	Midnt	00:00-08:00		7655	0.057	92
11	Thursday	Day	08:00-16:00		7174	0.054	84
12	Thursday	Swing	16:00-00:00		7490	0.056	76
13	Friday	Midnt	00:00-08:00		7092	0.053	68
14	Friday	Day	08:00-16:00		7875	0.059	60
15	Friday	Swing	16:00-00:00		7925	0.059	52
16	Saturday	Midnt	00:00-08:00		7904	0.059	44
17	Saturday	Day	08:00-16:00		3023	0.023	36
18	Saturday	Swing	16:00-00:00		7063	0.053	28
19	Sunday	Midnt	00:00-08:00		2662	0.020	20
20	Sunday	Day	08:00-16:00		5550	0.042	12
21	Sunday	Swing	16:00-00:00		7877	0.059	4

	1	2	3
HPAL reported radionuclide	BE-7	NA-24	BR-76
decay constant (1/HR)	5.41E-04	4.61E-02	4.28E-02
sum of decay factors	9.57E-01	1.24E-01	1.34E-01
decay factor, shift 1	1.34E-02	7.59E-06	1.31E-05
decay factor, shift 2	4.72E-02	3.86E-05	6.49E-05
decay factor, shift 3	4.92E-05	5.79E-08	9.48E-08
decay factor, shift 4	5.13E-02	8.70E-05	1.39E-04
decay factor, shift 5	5.15E-02	1.26E-04	1.95E-04
decay factor, shift 6	5.36E-02	1.88E-04	2.84E-04
decay factor, shift 7	5.16E-02	2.61E-04	3.84E-04
decay factor, shift 8	5.54E-02	4.04E-04	5.79E-04
decay factor, shift 9	5.46E-02	5.73E-04	7.99E-04
decay factor, shift 10	5.46E-02	8.25E-04	1.12E-03
decay factor, shift 11	5.14E-02	1.12E-03	1.48E-03
decay factor, shift 12	5.39E-02	1.69E-03	2.18E-03
decay factor, shift 13	5.13E-02	2.31E-03	2.90E-03
decay factor, shift 14	5.72E-02	3.71E-03	4.54E-03
decay factor, shift 15	5.78E-02	5.40E-03	6.43E-03
decay factor, shift 16	5.79E-02	7.80E-03	9.03E-03
decay factor, shift 17	2.22E-02	4.31E-03	4.86E-03
decay factor, shift 18	5.22E-02	1.46E-02	1.60E-02
decay factor, shift 19	1.98E-02	7.94E-03	8.49E-03
decay factor, shift 20	4.14E-02	2.39E-02	2.49E-02
decay factor, shift 21	5.90E-02	4.91E-02	4.98E-02

*LIST OF MEDIA EFFICIENCY FACTORS**

Radio-nuclide	lambda (1/hr)	collection media	collection efficiency
AU-192	1.40E-01	charcoal	0.65
AU-193	3.93E-02	charcoal	0.65
AU-194	1.75E-02	charcoal	0.65
AU-196N	7.14E-02	charcoal	0.65
BR-76	4.28E-02	charcoal	0.65
BR-77	1.22E-02	charcoal	0.65
BR-82	1.964E-02	charcoal	0.65
CL-38	1.12E+00	charcoal	0.65
CL-39	7.40E-01	charcoal	0.65
GD-146	5.98E-04	charcoal	0.65
HG-193	1.68E-01	charcoal	0.65
HG-193M	6.24E-02	charcoal	0.65
HG-195	7.30E-02	charcoal	0.65
HG-195M	1.73E-02	charcoal	0.65
HG-197	1.08E-02	charcoal	0.65
HG-197M	2.91E-02	charcoal	0.65
HG-203	6.20E-04	charcoal	0.65
I-126	2.22E-03	charcoal	0.65
I-131	3.59E-03	charcoal	0.65
IR-188	1.67E-02	charcoal	0.65
OS-183	5.33E-02	charcoal	0.65
OS-183M	7.00E-02	charcoal	0.65
OS-185	3.07E-04	charcoal	0.65
PT-191	1.03E-02	charcoal	0.65
RE-181	3.47E-02	charcoal	0.65
RE-182	5.46E-02	charcoal	0.65
RE-183	4.13E-04	charcoal	0.65
S-38	2.45E-01	charcoal	0.65
OS-182	3.22E-02	charcoal	0.65
TA-182	2.51E-04	charcoal	0.65
TM-172	1.09E-02	charcoal	0.65
XE-125	4.13E-02	charcoal	0.20
XE-127	7.93E-04	charcoal	0.20
AG-110M	1.16E-04	paper	1.00
AG-111	3.88E-03	paper	1.00
BE-7	5.41E-04	paper	1.00
CO-56	3.74E-04	paper	1.00
CO-57	1.07E-04	paper	1.00
CO-58	4.08E-04	paper	1.00
CO-60	1.50E-05	paper	1.00

LIST OF MEDIA EFFICIENCY FACTORS*, CONTINUED*

Radio-nuclide	lambda (1/hr)	collection media	collection efficiency	
K-42	5.61E-02	paper	1.00	
K-43	3.12E-02	paper	1.00	
K-44	1.88E+00	paper	1.00	
LU-172	4.31E-03	paper	1.00	
LU-173	5.77E-05	paper	1.00	
MG-28	3.25E-02	paper	1.00	
MN-52	5.07E-03	paper	1.00	
MN-54	9.25E-05	paper	1.00	
MN-56	2.91E-01	paper	1.00	
NA-22	3.04E-05	paper	1.00	
NA-24	4.61E-02	paper	1.00	
NB-95	8.22E-04	paper	1.00	
NI-57	1.93E-02	paper	1.00	
PM-143	1.09E-04	paper	1.00	
RB-83	3.35E-04	paper	1.00	
SB-124	4.80E-04	paper	1.00	
SC-44	1.67E-01	paper	1.00	
SC-44M	1.18E-02	paper	1.00	
SC-46	3.44E-04	paper	1.00	
SC-47	8.44E-03	paper	1.00	
SC-48	1.58E-02	paper	1.00	
SE-75	2.40E-04	paper	1.00	
SN-113	2.51E-04	paper	1.00	
TL-198	1.31E-01	paper	1.00	
TL-199	9.37E-02	paper	1.00	
TL-200	2.65E-02	paper	1.00	
TL-201	9.43E-03	paper	1.00	
TL-202	2.37E-03	paper	1.00	
V-48	1.79E-03	paper	1.00	
Y-88	2.71E-04	paper	1.00	
ZN-65	1.18E-05	paper	1.00	
ZR-95	4.48E-04	paper	1.00	
None Detected	0	N/A	1.00	**
NDA	0	N/A	1.00	**
None	0	N/A	1.00	**
<MDA	0	N/A	1.00	**
K-40	6.18E-14	charcoal	0.65	
As-73	3.60E-04	charcoal	0.65	

K-40 added for May 1998 ES-2 P/VAP; detected in charcoal; assume 0.65 efficiency

As-73 added for November 1998 ES-2 P/VAP report; detected on charcoal, assume 0.65 efficiency

*These collection efficiencies were developed by LANSCE personnel in the late 1980s and have been used for analyses since that time. See memo ESH-17:99-251 for analysis of these values.

**These data are included to allow proper analysis by the spreadsheet.